APPENDIX D

REMEDIAL ACTIONS, INTERIM REMEDIAL ACTIONS, AND TECHNICAL DEMONSTRATIONS

APPENDIX D

REMEDIAL ACTIONS, INTERIM REMEDIAL ACTIONS, AND TECHNOLOGY DEMONSTRATIONS

This appendix provides a listing of various types of remedial actions and technology demonstrations that have been implemented at numerous IRP sites at Hill AFB. Locations, descriptions, and timeframes of each action or demonstration, as well as lessons learned are provided on Table D-1. The AFCEE Remediation Matrix as presented on Table D-2, has been used as a starting point for IRAs and technology demonstrations on many projects.

TABLE D-1
REMEDIAL ACTIONS, INTERIM REMEDIAL ACTIONS, AND TECHNOLOGY DEMONSTRATIONS
(1 of 7)

OU	Site Code	Site Description	Action (Date Completed)	Purpose	Initial Expectation	Status	Outcome/Lessons Learned	Regulatory Program
-	-	Little Mountain Radioactive Disposal Site	Fencing/posting signs (institutional controls) (1996)	IRA	Provide for public safety by restricting access.	Completed	Has operated as expected.	GWP
-	ST015	Building 914 Fuel Spill	SVE and Bioventing (1991)	TD	Reduce contamination levels in soils.	Completed	Technology was effective in reducing contaminant levels in soil.	UST
-	ST035	Bldg 280 (UST)	Bioventing/LNAPL recovery/ Ground-water monitoring	IRA/RA	Remove LNAPL and decrease soil contaminant levels.	In progress	Bioventing in soils has proved effective.	UST
-	ST036	Bldg 510 (UST)	Bioventing/GW monitoring (1994)	RA	Reduce soil contamination to below action levels.	Completed	Proved effective in reducing contaminant levels to help bring site to closure.	UST
-	ST037	Bldg 214 (UST)	Bioventing/Vapor extraction; GW monitoring (1994)	IRA/RA	Let natural biological processes reduce contamination, but enhance the process by adding needed oxygen.	Completed	Proved effective in reducing contaminant levels and helped bring site to closure. (See outcome for ST56).	UST
-	ST038	Bldg 1141 (UST)	Long term monitoring (intrinsic bioremediation)	RA	Let natural biologic processes reduce contaminant levels in soil and ground water.	LTM	Ongoing research, preliminary results suggest attenuation is occurring.	UST
-	ST049	Bldg 41 (UST)	Intrinsic bioremediation/GW monitoring (1996)	LTM/ natural attenua-tion	Let natural biologic processes reduce contaminant levels.	Completed	Proved effective in reducing contaminant levels to help bring site to closure.	GWP
-	ST050	Bldg 204 (UST)	Bioventing (1993)	IRA/RA	Let natural biological processes reduce contamination, but enhance the process by adding needed oxygen.	Completed	Proved effective in reducing contaminant levels and helped bring site to closure. (See outcome for ST56).	UST
-	ST055	Site 388 (UST)	Bioventing/GW monitoring (1997)	RA	Let natural biological processes reduce contamination, but enhance the process by adding needed oxygen.	Completed	Bioventing reduced contaminant concentrations in the soil.	UST
-	ST056	Bldg 924 (UST)	Bioventing (1993)	IRA/RA	Let natural biological processes reduce contamination, but enhance the process by adding needed oxygen.	Completed	Proved effective in reducing contaminant levels and helped bring site to closure. Bioventing has sped up the natural degradation process significantly.	
-	ST059	Bldg 5026 (UST)	Intrinsic bioremediation (1993)	LTM/ natural attenua-tion	Let natural biological processes reduce contaminant levels.	Completed	Successfully reduced contaminant levels to bring site to closure.	UST
-	ST060	Bldg 592 (UST)	Abatement—Contaminated Soils Removed (1993)	Site remedia-tion	Remove contaminated soil.	Clean closure completed 1993	Remediation goal was reached by soil removal; however, compared to other sites remediated using bioventing technologies, it is much more cost effective to treat UST contaminated soil on site.	UST
-	ST061	Bldg 870 (UST)	JP-4 Recovery/Residential vapor monitoring/ Bioventing (1992)	IRA/CA	Recover LNAPL and remediate soils to below action levels.	Recovering JP-4 since June 1992; testing several types of recovery systems	LNAPL recovery has been minimal (only 960 gallons), but ground-water plume size has not increased and contaminant levels are decreasing.	UST
-	ST061	Bldg 870 (UST)	Natural Attenuation (1993-Present)	RA	Modeling would produce favorable results to warrant full-scale study	LTM	Natural attenuation was well-documented, is actively occurring and has been monitored since 1994.	UST

TABLE D-1
REMEDIAL ACTIONS, INTERIM REMEDIAL ACTIONS, AND TECHNOLOGY DEMONSTRATIONS
(2 of 7)

OU	Site Code	Site Description	Action (Date Completed)	Purpose	Initial Expectation	Status	Outcome/Lessons Learned	Regulatory Program
-	ST063	Bldg 236 (UST)	Bioventing/GW monitoring (1992)	RA	Reduce soil contamination to below action levels.	Completed	Proved effective in reducing contaminant levels to help bring site to closure.	UST
-	ST064	Bldg 228 (UST)	Bioventing/GW monitoring (1992)	RA	Reduce contaminants in soil.	Completed	Site was successfully remediated.	UST
-	ST066	Bldg 4301	Bioventing/GW monitoring (1997)	IRA/RA	Reduce contaminant levels to below action levels.	Completed; DD signed June 1993		UST
-	ST067	Bldg 1705	Contaminated Soils Removal (1993)	IRA/RA	Remove contaminated soils around USTs.	Completed; DD signed September 1993	Proved effective to reduce contamination but at a relatively high cost.	GWP
-	ST068	Site 10779 (UST)	Contaminated Soils Removal; Bioventing/GW monitoring (1992)	RA	Remove contaminated soils around tanks and reduce remaining contamination through bioventing.	Completed soil removal in March 92. Bioventing completed.	Proved effective in reducing contaminant level and help bring site to closure. Remediation through bioventing was much more cost effective than soil removal.	UST
-	ST069	Bldg 722 (UST)	Abatement—Contaminated Soils Removal (1995)	Site remedi-ation	Remove contaminated soil.	Clean closure in 1995	It is much more cost effective to treat UST contaminated soil on site.	UST
-	ST070	Bldg 1132 (UST)	Abatement—Contaminated Soils Removal (1995)	Site remedia-tion	Remove contaminated soil.	Clean closure in 1995	It is much more cost effective to treat UST contaminated soil on site.	UST
-	ST071	JP-4 Refueling Spill (Bldg 914)	SVE, LNAPL recovery by vacuum extraction and ground-water monitoring	RA	Remove LNAPL from perched water bearing zone.	In operation; DD signed August 1991	Complex subsurface conductions and continued POL spills have extended this effort.	UST
			Dual Phase and vacuum extraction (1994)	TD	Remove LNAPL from perched water bearing zone and reduce contaminants in soil matrix	Completed	Did not prove effective in removing LNAPL	
-	ST073	Bldg 1286 (UST)	Contaminated Soils Removal; Bioventing/GW monitoring (1997)	RA	Remove contaminated soils around tanks and reduce remaining contamination through bioventing.	Completed soil removal and bioventing in progress	Proved effective in reducing contaminant level and help bring site to closure. Remediation through bioventing was much more cost effective than soil removal.	GWP
-	ST074	Bldg 260 (UST)	LNAPL recovery/Bioventing	IRA	Remove LNAPL and decrease soil contaminant levels.	In operation	Approximately 14,000 gallons of LNAPL have been removed. Bioventing in soils has proved effective.	UST
-	ST079	UTTR 40002 (UST)	Contaminated Soil Removal; Bioventing/GW monitoring (1994)	RA	Remove contaminated soils around tanks and reduce remaining contamination through bioventing.	Completed soil removal. Bioventing in progress.	Proved effective in reducing contaminant level and help bring site to closure. Remediation through bioventing has been much more cost effective than soil removal.	UST
-	ST083	Bldg 771 (UST)	Intrinsic bioremediation/GW monitoring (1994)	LTM/ natural attenua-tion	Let natural biologic processes reduce contaminant levels.	Completed	Proved effective in reducing contaminant levels to help bring site to closure.	UST
-	ST085	USTs 1313, 1314	Bioventing/GW monitoring (1995)	IRA/RA	Reduce soil contamination to below action levels.	In progress; DD signed March 1996		GWP
-	ST086	Bldg 1134	Bioventing/GW monitoring (1997)	IRA/RA	Reduce soil contamination to below action levels.	Completed	Proved effective in reducing contaminant level and help bring site to closure. Remediation through bioventing was much more cost effective than soil removal.	UST

TABLE D-1
REMEDIAL ACTIONS, INTERIM REMEDIAL ACTIONS, AND TECHNOLOGY DEMONSTRATIONS
(3 of 7)

OU	Site Code	Site Description	Action (Date Completed)	Purpose	Initial Expectation	Status	Outcome/Lessons Learned	Regulatory Program
-	ST086	Bldg 1703	Bioventing/GW monitoring (1997)	IRA/RA	Reduce contaminant levels to below action levels.	Completed	Proved effective in reducing contaminant levels to help bring site to closure.	UST
-	ST086	Bldg 1904	Bioventing/GW monitoring (1997)	IRA/RA	Reduce soil contamination to below action levels.	Completed	Proved effective in reducing contaminant levels to help bring site to closure.	UST
-	ST086	Bldg 2025	Bioventing/GW monitoring (1997)	IRA/RA	Reduce contaminant levels to below action levels.	In progress		UST
-	ST086	Bldg 2104	Bioventing/GW monitoring (1997)	IRA/RA	Reduce soil contamination to below action levels.	Completed	Proved effective in reducing contaminant levels to help bring site to closure.	UST
-	ST086	Bldg 2203	Bioventing/GW monitoring (1997)	IRA/RA	Reduce contaminant levels to below action levels.	Completed July 95	Proved effective in reducing contaminant levels to help bring site to closure.	UST
-	ST086	Bldg 454	Vapor extraction	IRA/RA	Reduce contaminant levels to below action levels.	In progress. Closure planned early for FY98	Vapor extraction was very effective.	UST
-	ST087	Little Mountain Tank Farms	LNAPL extraction/GW monitoring	TD	Remove LNAPL and reduce contaminant levels.	In progress; DD is on hold	LNAPL recovery has been below expectations; skimmer pumps did not work at this site, currently bailing LNAPL on regular basis	GWP
-	ST088	Little Mountain Fire Training Area	Intrinsic remediation/GW monitoring (1997)	RA	Let natural biologic processes reduce contaminant levels.	Completed		GWP
1	Several	U1-303, U1-304	Seep/Spring Collection/Treatment Systems (1985)	IRA	Collect and treat contaminated ground-water discharge at these two seep and spring locations.	In operation, LTM	Operated as expected.	FFA
1	Several	U1-307	Seep/Spring Collection/Treatment System (1995)	IRA	Collect and treat contaminated ground water discharged from U1-307.	In operation, LTM	Operated as expected.	FFA
1	FT009	Fire Training Area 2	Bioventing (1995)	TD	Assess whether bioventing is an effective remedial technology at FTA-2.	Completed	Proved to be very successful for both soil and ground-water remediation. Ground water is now below MCLs.	FFA
1	FT009, LF001, 002	Landfill 3 & 4, Fire Training Area 1	Eastern IRA containment system upgrade	IRA		On hold		FFA
1	FT009, LF001, 002, WP002	Landfills 3 & 4, Chemical Disposal Pits 1 & 2, and Fire Training Areas 1 & 2	Cap and Slurry Wall (1987)	IRA	Significantly reduce recharge to OU 1 disposal sites and to reduce transport of contaminants to off-Base area's.	In operation, LTM	Initial testing indicated that the cap met permeability criteria, however, burrowing animals and deep rooted plants have compromised cap integrity. The slurry wall did not meet expectations. Lessons learned from this project suggests more stringent over site should be required during construction activities, maintenance of cap is required to maintain its effectiveness, and upgradient hydraulic capture is needed to maintain slurry wall effectiveness.	FFA
1	FT009, LF001, 002, WP002	Landfills 3 & 4, Chemical Disposal Pits 1 & 2, and Fire Training Areas 1 & 2	IWTP Hookup (1988/Upgraded 1994)	IRA	Transport contaminated ground water from OU 1 to IWTP for treatment.	In operation, LTM	System has operated as expected.	FFA
1	FT009, LF001, 002, WP002	Landfills 3 & 4, Chemical Disposal Pits 1 & 2, and Fire Training Areas 1 & 2	Ground-water control collection and treatment, CAP repair (2000)	RA	Collect and convey contaminated ground-water from OU1 to WTP for treatment	Under construction		FFA

TABLE D-1
REMEDIAL ACTIONS, INTERIM REMEDIAL ACTIONS, AND TECHNOLOGY DEMONSTRATIONS
(4 of 7)

OU	Site Code	Site Description	Action (Date Completed)	Purpose	Initial Expectation	Status	Outcome/Lessons Learned	Regulatory Program
1	FT009, WP0002	Chemical Disposal Pits 1 & 2, Fire Training Area 1	Surfactant Treatability Study Bench Test (1994)	TD	Assess if surfactants were an applicable technology for OU 1 contaminant removal.	Completed	Results suggested that it could be an effective technology but emulsion formation may cause long term problems in analyzing data.	FFA
1	LF001	Chemical Disposal Pits 1 & 2, and Western Area of OU 1	Replaced private well water supply with municipal water (residents) and seeps/springs (livestock) (1990)	IRA	Reduce exposure to contaminated ground water by providing an alternative water source.	In operation, LTM	Has reduced exposure of off-Base Resident to contaminated ground water.	FFA
1	WP002	Chemical Disposal Pit 1	Soil vapor extraction (1995)	TD	Assess applicability of SVE to remediate vadose zone soil at CDPs1 and 2.	Completed	Removed a significant mass of contaminants, however, this mass was insignificant compared to the total mass of contaminants at CDPs 1 and 2.	FFA
1	WP002	Chemical Disposal Pits 1 & 2	Hookup ground-water treatment (1986)	IRA	Collect and treat contaminated OU 1 ground water.	In operation, LTM	Well spacing was not adequate for complete capture of contaminants. However, the system has demonstrated that capture is possible with adjustments to system design. Lessons learned included; the need to base system design on hydrogeology of site and extraction trenches are more effective than the wells.	FFA
1	WP002	Chemical Disposal Pits 1 & 2	A series of nine technology demonstrations (1995):					
			1. Ethanol Flushing (1995)	TD	To assess innovative technology effectiveness for OU 1 site remediation, to provide data to support the FS and ROD, and to provide engineering and cost data for full scale implementation.		Numerous technical and administrative lessons were learned and have been summarized in a memorandum that is available from the EMR OU 1 files.	FFA
			2. Air Sparging/Soil Vapor Extraction (1996)	TD				FFA
			3. In-Well Aeration/Vertical Cosolvent Solubilization (1996)	TD				FFA

TABLE D-1
REMEDIAL ACTIONS, INTERIM REMEDIAL ACTIONS, AND TECHNOLOGY DEMONSTRATIONS
(5 of 7)

OU	Site Code	Site Description	Action (Date Completed)	Purpose	Initial Expectation	Status	Outcome/Lessons Learned	Regulatory Program
			4. Cosolvent Mobilization (1996)	TD		Completed		
			5. Complexing Sugar Flush (1996)	TD		Completed		
			6. Surfactant Solubilization (1996)	TD		Completed		
			7. Surfactant Middle Phase Microemulsion (1996)	TD		Completed		
			8. Steam Injection (1996)	TD		Completed		
			9. Single Phase Micro-emulsions (1996)	TD		Completed		
1	WP002	Chemical Disposal Pits 1 & 2	Western OU 1 containment system	IRA		On hold		FFA
2	Several	Chemical Disposal Pit 3	Install new holding tank at IWTP (1993)	WW storage	Increase storage capacity at IWTP.	Completed	Fulfilled expectations by providing additional storage capacity	FFA
2	Several	Davis/Weber Canal	Seal leaks in canal near OU 2	RA	Reduce infiltration from canal.	Completed	Significant infiltration reduction	FFA
2	WP007	Seep U2-304	Seep Collection System (1999)	RA	Collect seep and convey to existing treatment system	Completed	Operating as expected	FFA
2	WP007	Chemical Pit 3	Shallow, off-Base ground-water Collection gallery; Treatment of springs; Air stripper; GAC (1987)	IRA	Treat storage water and surface water.	Replaced by permanent system in 1999	Has effectively treated ground water and surface water	FFA
2	WP007	Chemical Pit 3	DNAPL Recovery System—Evaluation/modification of treatment system (1993)	IRA	To remove DNAPL.	In operation, LTM	To date the SRS has removed over 35,000 gallons of DNAPL	FFA
2	WP007	Chemical Pit 3	Extraction Trench (1997)	RA	Will reduce off-Base contaminated ground-water plume	Completed Dec-97, in operation.	Construction went smoothly	FFA
2	WP007	Chemical Pit 3	Cap and Slurry Wall around source area; SVE source area; ground-water collection and treatment (1996, 1997)	RA	Contain contaminated ground water on Base.	In operation, LTM		FFA
2	WP007	Chemical Pit 3	Surfactant Flushing (1997, 1999)	TD	Test feasibility of this method to mobilize and remove contamination from soil matrix.	In progress	Very encouraging. Significant mass removals (›90%) were documented during 1997 trial. Expected completion date – Fall 2000	FFA
2	WP007	Chemical Pit 3	Steam Injection/Vapor Extraction (1997, 1999)	TD	Test feasibility of this method to mobilize and remove contamination from soil matrix.	Completed	Removed 2,400 gallons of product.	FFA
2	WP007	Chemical Pit 3	Surfactant Foam Test (1997, 1999)	TD	Test feasibility of contaminant removal in soil matrix using foam surfactant.	Completed	Surfactant successfully deployed in low permeability zone. Foam effective at controlling mobility at higher permeability zones.	FFA
2	WP007	Chemical Pit 3	Cometabolic bioventing test	TD	Assess the effectiveness of this technology to remove contaminants from soil matrix.	In progress	Expected completion date – mid 2000	FFA
2	WP007	Chemical Pit 3	Partitioning tracer test	TD	Determine remaining residual DNAPL.	Completed	Results indicate 1,100 gallons remaining. Full scale surfactant flood underway to remove DNAPL	FFA

TABLE D-1
REMEDIAL ACTIONS, INTERIM REMEDIAL ACTIONS, AND TECHNOLOGY DEMONSTRATIONS
(6 of 7)

OU	Site Code	Site Description	Action (Date Completed)	Purpose	Initial Expectation	Status	Outcome/Lessons Learned	Regulatory Program
3	ST004	Sodium Hydroxide Tank	Asphalt Cap (1993) Asphalt Cap Replaced (1999)	IRA/RA	Reduce infiltration and limit possible contaminant migration.	Continued annual inspection, LTM	Cap appears to be operating effectively.	FFA
3	ST018	Buildings 511 & 514	SVE (1997)	RA	Remove VOCs in soil.	Completed	Remedial action completed successfully. Site closed	FFA
3	ST018	Buildings 511 & 514 Vehicle Maintenance	Soil Vapor Extraction TD (1995)	TD	Test the feasibility of soil vapor extraction as a remedial alternative.	Completed	This testing showed that SVE was effective in reducing contaminant levels in the soil matrix.	FFA
3	WP005	Berman Pond	Cap (1984)	IRA	Reduce infiltration into perched ground water zone and reduce contaminant transport to the shallow aquifer.	Completed	Cap did not cover the entire areal extent of the pond so it was not effective in reducing infiltration. Additional capping required.	FFA
3	WP005	Berman Pond	Asphalt Cap (1997)	RA	Minimize subsurface water infiltration. Test perched water hydraulic properties to assess dewater feasibility..	Completed cap Dec 97		FFA
3	WP005	Berman Pond	Pond Dewatering (1995)	TD	Test small scale well field design to assess its dewatering capabilities.	Completed	The hydraulic properties for dewatering design were obtained.	FFA
3	WP005	Berman Pond	Expanded Pond Dewatering	TD/RA	Remove perched ground water.	In operation	Indicate that dewatering in the Berman Pond perched zone is possible, but cannot be achieved until infiltration into the perched zone is significantly reduced through cap construction. Retained as part of RA.	FFA
4	LF011	Ground-water Plume near Landfills 1 and 2	Ground-water contaminant and extraction system	RA	Contain source areas to control off-Base transport of TCE contaminated ground water.	Design complete. Awaiting resolution of off-base real estate issue.		FFA
4	LF011	Landfill 1	Ground-water Recovery and Treatment (horizontal drains and air stripper) (1993)	TD	Test feasibility of ground water extraction using horizontal drains and treatment by a shallow-tray air stripper.	Upgraded to permanent facility in 1996	To date the drain system drained and treated approximately 10.2 million gallons of ground water. Air stripper has been effective at meeting or exceeding discharge requirements.	FFA
4	LF011	Landfill 1	Ground-water Recovery and Treatment (horizontal drains and air stripper) (1996)	RA	Continued satisfactory operation.	In operation, LTM	Continued satisfactory operation.	FFA
4	LF011	Landfill 1	In-situ funnel and gate (MERD Technology) (1994)	TD	Test MERD Technology to remove the contaminants from ground-water	Completed	Technology was effective only for very short durations due to problems encountered with precipitation of various carbonates and hydroxides.	FFA
4	LF011	Landfill 1	Landfill cap (1996)	RA	Reduce infiltration into landfill	Completed, LTM		FFA
5	SD016	Bamberger Pond	Pond Liner	IRA	Limit storm water infiltration into ground water.	Deleted	Study results indicate metals contamination is related to natural processes.	FFA
5	SS017	Rail Shop	Soil Management System (1995)	IRA	Vapor extract VOCs from contaminated soil excavated from aeration curtain and from OU 5 and other site investigations.	In operation, LTM	Successfully reduced VOC levels in soil to allow for on-Base spreading of “clean” soils.	FFA

TABLE D-1
REMEDIAL ACTIONS, INTERIM REMEDIAL ACTIONS, AND TECHNOLOGY DEMONSTRATIONS
(7 of 7)

OU	Site Code	Site Description	Action (Date Completed)	Purpose	Initial Expectation	Status	Outcome/Lessons Learned	Regulatory Program
5	SS017	Rail Shop, off-Base	Expand Aeration Curtain (1996)	IRA	Treat TCE contaminated ground water as it leaves the Base and reduce contaminant levels to below MCLs.	In operation, LTM	Problems included Guar solution that broke down causing trench to collapse due to contaminated mixing water; lessons learned included: need to keep mixing waters clean.	FFA
5	SS017	Rail Shop, off-Base	Ground-Water Collection Trench	IRA	Collect and treat contaminated ground-water in off-Base locations.	On hold pending results of on-going plume definition		FFA
5	SS017	Rail Shop, off-Base	Ground-water extraction system (wells)	IRA	Pump and treat TCE contaminated ground-water in off-Base areas.	In operation, LTM	Performing as expected.	FFA
6	OT026	Off-Base Ground-water Plume	Pump and treatment system with air stripper (1996)	EE/CA	Collect and treat contaminated ground water.	In operation, LTM	Performing as expected.	FFA
6	OT026	Off-Base Springs and Pond	Off-Base Ground-water Treatment (springs), air stripper (1993)	EE/CA	Collect and treat contaminated ground-water in springs located off-Base.	In operation, LTM	Performed as expected.	FFA
6	OT026	On-Base Ground-water Plume	UVB/Air sparge SVE (1996)	TD	Assess effectiveness of UVB and air sparge SVE technologies to treat TCE contaminated ground-water at OU 6 to below MCL levels.	Completed	Technologies did not prove successful.	FFA
6	OT026	On-Base Ground-water Plume	Extraction wells, air stripping	RA	Collect and treat contaminated ground water.	In operation, LTM	Performing as expected.	FFA
7	ST031	Bldg 220 Underground	Removed oil-water separators, UST, Soil, and Capped, 1986	IRA	Remove contaminated soil	Completed	Reduced contaminant levels by removing contaminated soil. Very costly to dispose of contaminated soils.	FFA/ RCRA
8	OT033	On-Base Ground-water Plume	Southern Base boundary hydraulic containment (extraction wells)	IRA	Minimize the transport of ground-water contamination to off-Base areas.	Under construction since Oct 97 (to complete in early 1998)	Discharge to POTW allowed.	FFA
8	OT033	On-Base Ground-water Plume	In-well redox technology evaluation	TD	Reduction in ground-water contaminant levels.	Assessment delayed to allow further definition of plume in potential study area.		

DD Decision Document
DNAPL Dense Non-Aqueous Phase Liquid
EE/CA Engineering Evaluation, Cost Analysis
FFA Federal Facility Agreement
FY Fiscal Year
GAC Granular Activated Carbon
GW Ground Water
GWP Ground-Water Protection Program
IRA Interim Remedial Action
IRA/CA Interim Remedial Action/Corrective Action
IROD Interim ROD
IWTP Industrial Wastewater Treatment Plant
LNAPL Light Non-Aqueous Phase Liquid
LTM Long-Term Monitoring
MERD Metal-Enhanced Reductive Dehalogenation
PD Pre-design
POL Petroleum, Oil and Lubricant
POTW Publicly-Owned Treatment Works
RA Remedial Action
SVE Soil Vapor Extraction
TD Technology Demonstration
UDERR Utah Division of Environmental Response and Remediation
UST Underground Storage Tank
UVB In-Well Air Stripping Technology
VOCs Volatile organic compounds
WW Wastewater

TABLE D-2

AFCEE REMEDIATION MATRIX—HIERARCHY OF PREFERRED ALTERNATIVES
(1 of 1)

	POL-Vadose Zone (i.e., jet fuel, diesel)	POL-Excavated Soil	Floating Product Deep (>20 ft)	Floating Product Shallow (<20 ft) Low Permeability	Floating Product Shallow (<20 ft) High Permeability	Dissolved Fuel In Ground Water (BTEX)	Chlorinated Solvents In Vadose Zone (i.e., TCE)	Dissolved Chlorinated Solvents In Ground Water	Heavy Metals In Vadose Zone	Heavy Metals In Excavated Soil	POL Vapor Treatment	Chlorinate Solvent Vapor Treatment
Natural Attenuation/Assimilation	1	1	1	1	1	1	1	1	1	1		
Bioventing	2	4					3 co-metabolism					
Soil Vapor Extraction	3	5					2					
Heat Enhanced Vapor Extraction	4						4					
Low Permeability Cover/Cap	5						6		3			
Excavate and/or Haul	6	8					7		4	4		
Composting (no tilling)		2										
Land Farming		3								2		
Low Temp Thermal Desorp		6										
Incineration (High Temp)		7										
Apparent vs. Actual Studies			2	2	2							
Passive Extraction Wells			4	5	4							
Hand Bail If Appropriate			3	3	3							
Vacuum Assist Pumping				4	5							
Dual Pump System			5									
Air Sparging						2		2				
Passive Treatment Wall						3		3				
Conventional Pump and Treat						4		4				
Slurry Wall						5		5				
Stabilization							5		2	3		
Permitted Direct Emission											1	1
Flare											2	
Biological Filter											3	2 co-metabolism
Catalytic Incineration											4	3
On-site Regenerated Polymer											5	4
Carbon Adsorption											6	5

This matrix is an attempt to rank technologies that should be considered for use at common Air Force sites. Managers should use this hierarchy for screening technologies and should be able to justify why a particular technology was selected over others with lower numbers. For instance, if soil vapor extraction (3) is the selected technology for POL in the vadose zone, then managers should be able to justify why neither natural attenuation (1) nor bioventing (2) was selected. The natural attenuation/assimilation alternative should always be considered first and, if selected, should be based on a scientifically defensible risk assessment.